COMP 333 Midterm #2 Practice Exam

This is representative of the topics and kind of questions you may be asked on the exam.

Prototype-Based Inheritance in JavaScript

1.a.) Define a constructor for Dog objects, where each Dog object has a name. An example code snippet is below, illustrating usage:

```
let d = new Dog("Rover"); // line 1
console.log(d.name);      // line 2; prints Rover
```

1.b.) Define a different constructor for `Dog`, which puts a `bark` method **directly** on the `Dog` objects. The `bark` method should print "Woof!" when called. Example usage is below:

```
let d = new Dog("Sparky");
d.bark(); // prints Woof!
```

1.c.) Define a method named growl for Dog objects, which prints "[dog name] growls" when called. Use Dog's **prototype**, instead of putting the method directly on Dog objects themselves. Example usage is below:

```
let d = new Dog("Rocky");
d.growl(); // prints Rocky growls
```

2.) Consider the JavaScript code below:

```
function Animal(name) { this.name = name; }
Animal.prototype.getName = function() { return this.name; }
function Bird(name) { this.name = name; }
Bird.prototype = { '__proto__': Animal.prototype };
Bird.prototype.fly = function() {
  console.log(this.getName() + " flies");
}
function Mouse(name) {
  this.name = name;
  this.squeak = function() {
    console.log(this.name + " squeaks");
  }
}
Mouse.prototype = { '__proto__': Animal.prototype };
Mouse.prototype.fly = Bird.prototype.fly;
let b1 = new Bird("Coco"); let b2 = new Bird("Sunny");
let m1 = new Mouse("Pip"); let m2 = new Mouse("Ruby");
```

Write a memory diagram which shows how memory looks after this program executes. Your diagram should include the objects and fields associated with `b1`, `b2`, `m1`, `m2`, `Mouse.prototype`, and `Bird.prototype`, `Animal.prototype`. You do not need to show what `Animal`, `Mouse`, and `Bird` refer to.

3.) Consider the JavaScript code below, adapted from the second assignment:

```
function List() {}
List.prototype.isList = function() { return true; }
function Cons(head, tail) {
  this.head = head;
  this.tail = tail;
}
Cons.prototype = new List();
Cons.prototype.isEmpty = function() { return false; }
function Nil() {}
Nil.prototype = new List();
Nil.prototype.isEmpty = function() { return true; }
let list1 = new Nil();
let list2 = new Cons("hi", list1);
```

Write a memory diagram which shows how memory looks after this program executes. Your diagram should include the objects and fields associated with `List`, `Cons`, `Nil`, `list1`, and `list2`.

4.) Consider the test suite below, using `assertEquals` from the second assignment:

```
function test1() {
  let t1 = new Obj("foo");
  assertEquals("foo", t1.field);
}

function test2() {
  let t2 = new Obj("bar");
  assertEquals("barbar", t2.doubleField());
}

function test3() {
  let t3 = new Obj("baz");
  // hasOwnProperty returns true if the object itself has the field,
  // otherwise it returns false.  If the field is on the object's
  // prototype instead (__proto__), it returns false.
  assertEquals(false, t3.hasOwnProperty("doubleField"));
}
```

Write JavaScript code which will make the above tests pass.

5.) Consider the JavaScript code below and corresponding output:

```
let three = new MyNumber(3);
let five = new MyNumber(5);

let eight = three.add(five);
let fifteen = three.multiply(five);

console.log(three.getValue());
console.log(five.getValue());
console.log(eight.getValue());
console.log(fifteen.getValue());


---OUTPUT---
3
5
8
15
```

Implement any missing code necessary to produce the above output.

6.) Consider the JavaScript code below and corresponding output, adapted from the second assignment:

```
function Cons(head, tail) {
  this.head = head;
  this.tail = tail;
}
function Nil() {}

let list = new Cons(1, new Cons(2, new Cons(3, new Nil())));
list.forEach((x) => console.log(x));

---OUTPUT---
1
2
3
```

Implement any missing code necessary to produce the above output.

Language Concepts

7.) In regards to memory management, Swift and Python (specifically `cpython`) both use reference counting, whereas Java and JavaScript both use garbage collection.

7.a.) In 1-3 sentences, in your own words, explain how garbage collection reclaims memory. Your description doesn't have to be detailed enough to implement a garbage collector, only detailed enough to get the gist of when memory would be reclaimed.

7.b.) In 1-3 sentences, in your own words, explain how reference counting reclaims memory. Your description doesn't have to be detailed enough to implement reference counting, only detailed enough to get the gist of when memory would be reclaimed.

7.c.) Name one advantage of reference counting over garbage collection.

7.d.) Name one advantage of garbage collection over reference counting.

8.) In 1-3 sentences, explain the difference between compilation and interpretation. Your answer does not need to be detailed enough to implement a compiler or interpreter.

9.) The Java Virtual Machine (JVM) is implemented as an interpreter over Java bytecode. Similarly, most JavaScript implementations are implemented as interpreters. However, most Java and JavaScript implementations support just-in-time (JIT) compilation.

9.a.) In 1-3 sentences, explain what JIT compilation does, in the context of an interpreter. Your answer doesn't need to be detailed enough to implement a JIT compiler.

9.b.) JIT compilers can sometimes generate faster code than traditional compilers. Why?

10.) Swift, Scala, and Haskell all support type inference. In 1-3 sentences, explain what type inference is, and how it relates to statically-typed and dynamically-typed languages. You don't have to provide enough detail to implement a type inferencer.

Functions in Swift

11.) Consider the following code snippet in Swift:

```
let temp = addThree(first: 2, 4, third: 8)
print(temp) // prints 14
```

Implement the `addThree` function below.